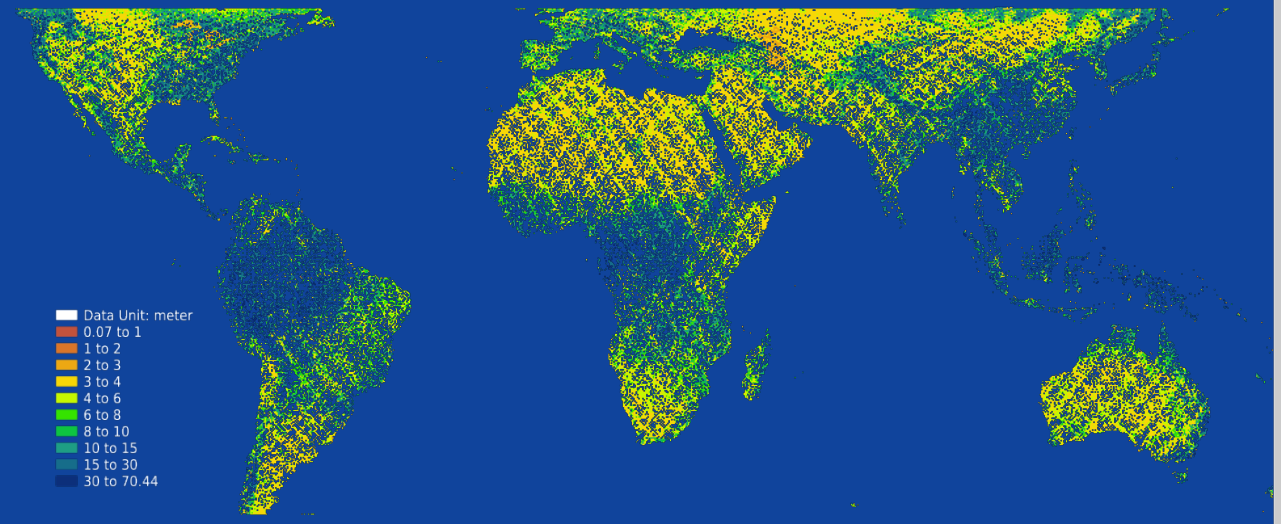
Synergistic Use of SAR and Lidar Data for Terrestrial Ecology Research

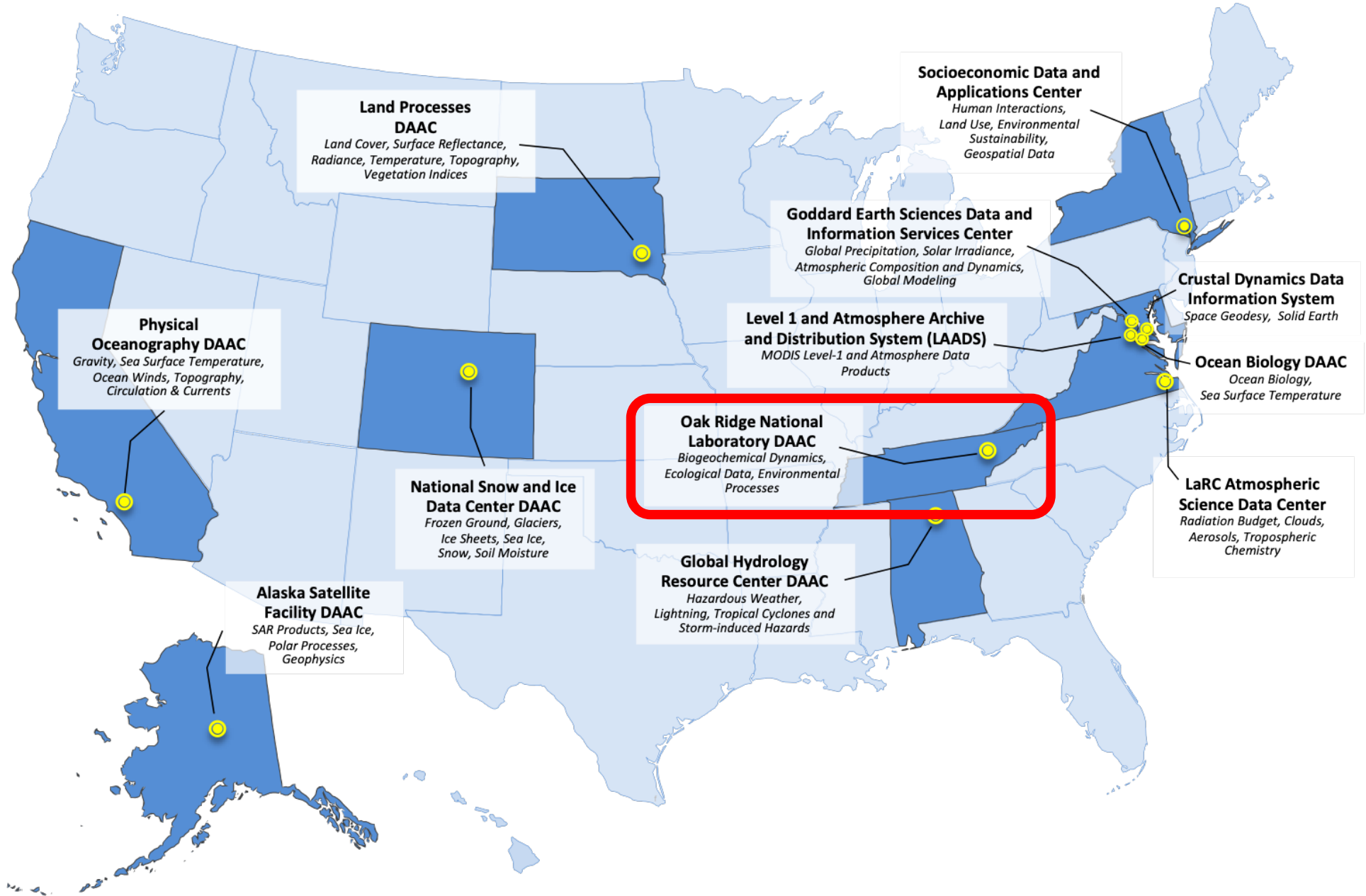
Overview of ORNL DAAC data and tools for terrestrial ecology research



Rupesh Shrestha (ORNL DAAC)
Michele Thornton (ORNL DAAC)
Yaxing Wei (ORNL DAAC)

The Oak Ridge National Laboratory Distributed Active Archive Center for Biogeochemical Dynamics operates under an interagency agreement between NASA and the U.S. Department of Energy

EOSDIS Distributed Active Archive Centers (DAAC)s



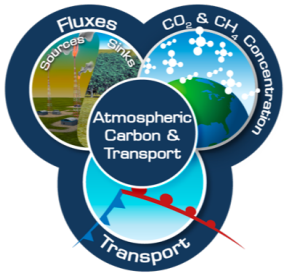
About ORNL DAAC

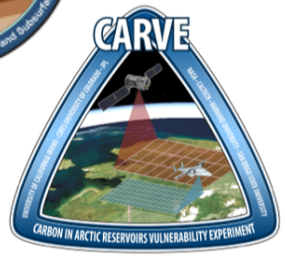
- Mission
  - Assemble, distribute, and provide data services for a comprehensive archive of terrestrial biogeochemistry and ecological dynamics observations and models to facilitate research, education, and decision-making in support of NASA's Earth Science.

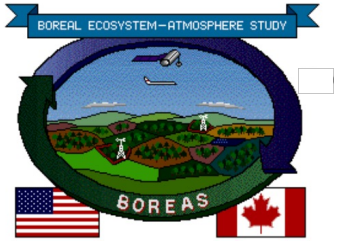
https://daac.ornl.gov

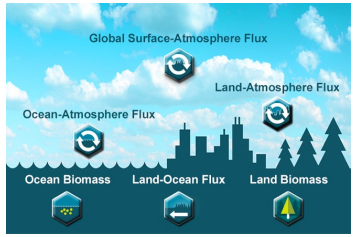
ORNL DAAC Products: 1,547

1,532 datasets and 15 models (as of July 2021)

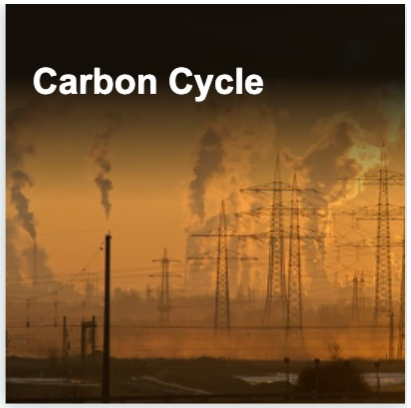


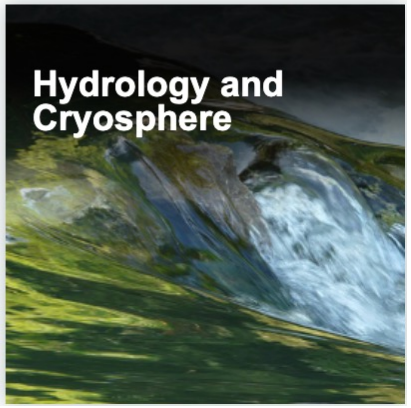






ORNL DAAC Products: Science Themes





Data Tools and Services at ORNL DAAC

MODIS

Obtain MODIS Land Product subsets for any location, area, and time period globally.

Visualize Subset Service Download

THREDDS

Find, visualize, and subset netCDF datasets.

Search Subset

Spatial Data Access Tool (SDAT)

Visualize and download geospatial datasets in user-selected file formats, extent, projection, and resolution through OGC standards.

Subset Service Visualize

Daymet

Get daily meteorological data for any North American location.

Visualize Subset Service

Airborne Data Visualizer

View and download in-situ measurements from multiple airborne missions.

Visualize Download

Soil Moisture Visualizer

Subset, view, and download harmonized soil moisture data across North America from AirMOSS, SMAP, SoilSCAPE, and other sources.

Visualize Download Subset

https://daac.ornl.gov/tools/

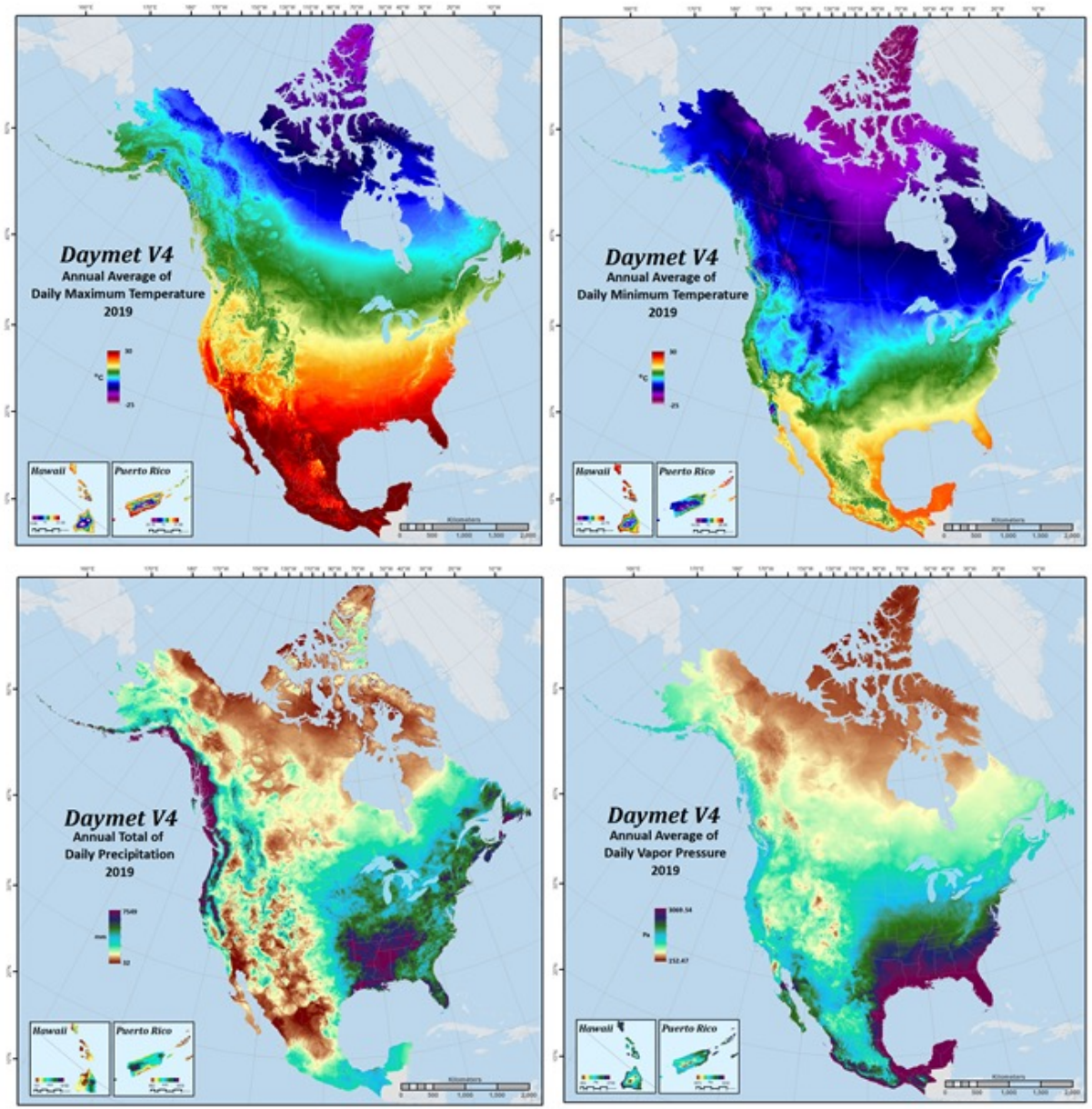
Weather and Climatic Variables

- Daymet V4
  - a daily meteorological dataset derived from land surface weather station observations
  - integrating vegetation structure with climatic variables can improve understanding of terrestrial ecosystems

Data Characteristics

Temporal / Spatial Resolution ….. Daily / 1km x 1 km
Years Available ….. 1980 – 2020
Spatial Region ….. North America, Hawaii, Puerto Rico

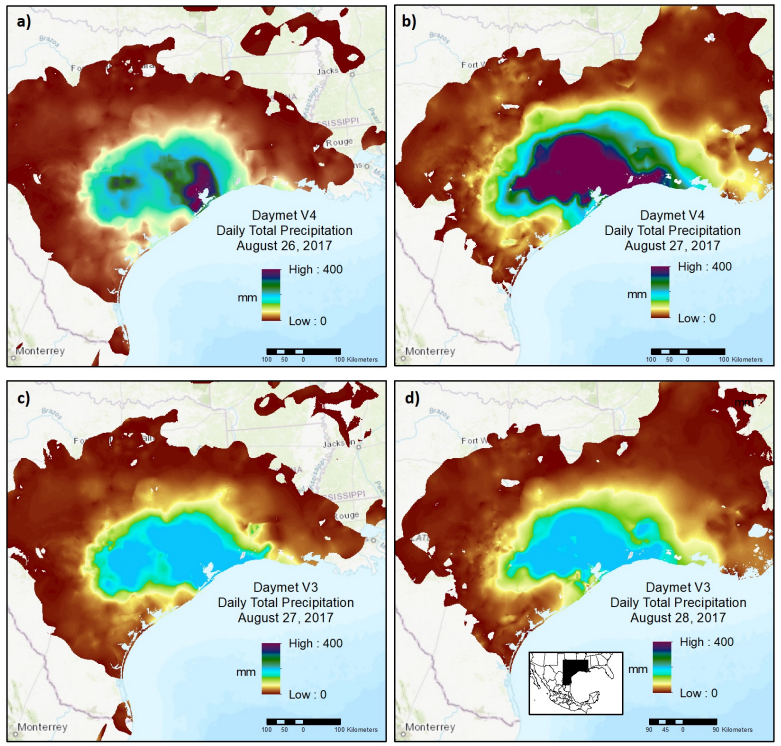
Daymet Data Products	
Variable	Units
maximum temperature	°C
minimum temperature	°C
shortwave radiation	W/m^2
vapor pressure	Pa
snow water equivalent	kg/m^2
precipitation	mm/day
day length	s/day



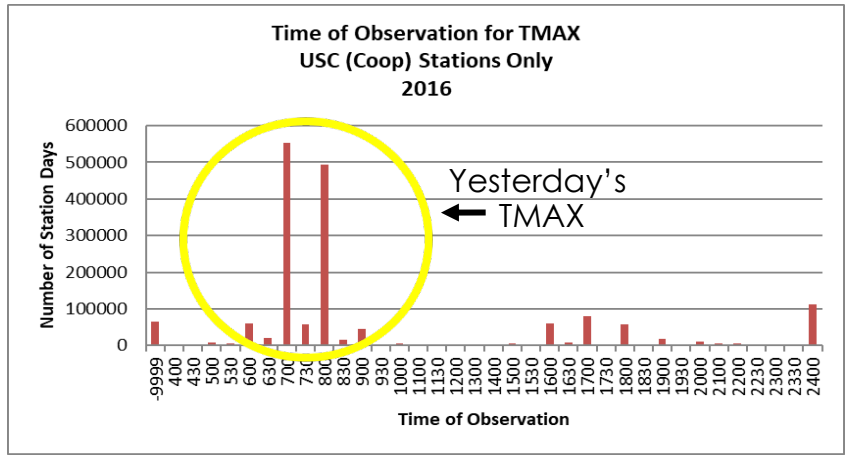
https://daymet.ornl.gov

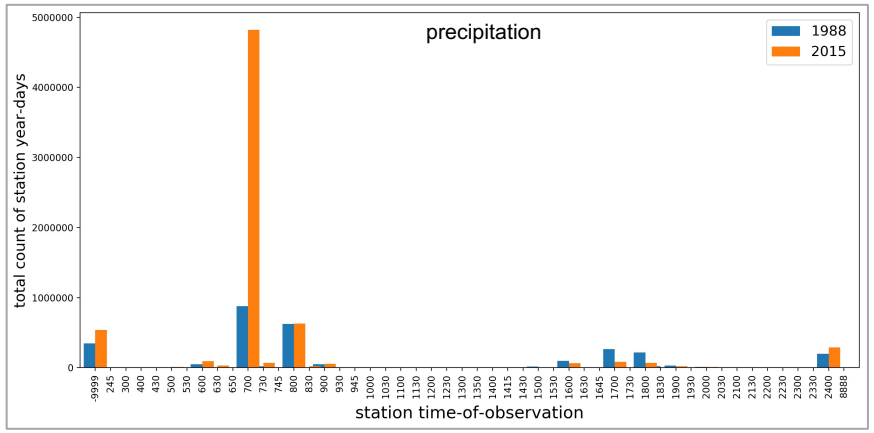
Daymet V4

- Version 4 – Data Released in December 2020
- Improvements include:
  - improvement to the three-dimensional regression model techniques in the core algorithm
  - reductions in the timing bias of input weather station measurements
  - novel approach to handling high elevation temperature measurement biases



Daily total precipitation for a sub-region that shows landfall of Hurricane Harvey in late August 2017. Top panels show two days from the Daymet V4. Bottom panels show the corresponding days from the V3 dataset. Date shifting based on time-of-observation bias for precipitation are shown.



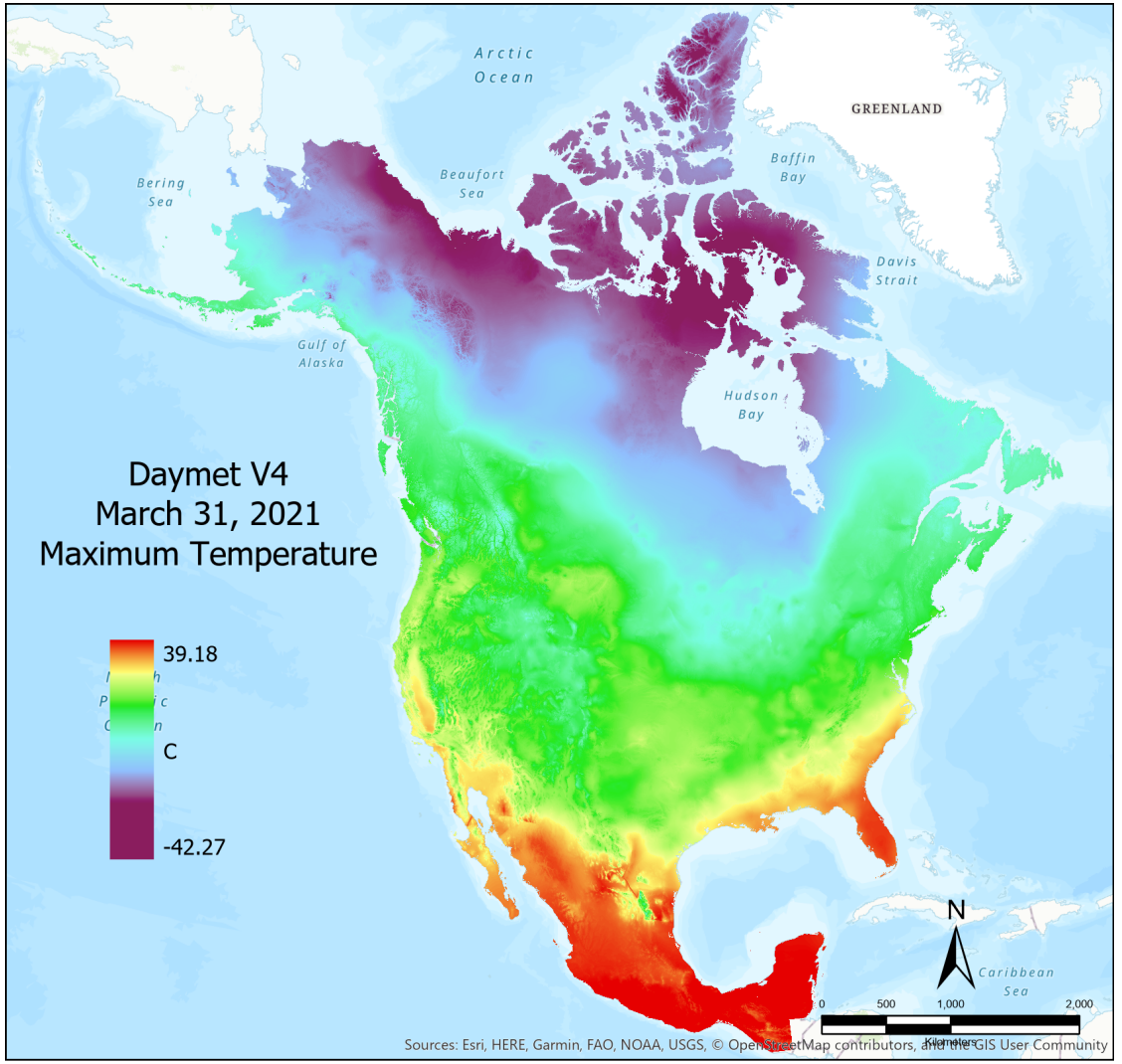


Thornton, P.E., R. Shrestha, M. Thornton, S.-C. Kao, Y. Wei, B.E. Wilson (2021) Gridded daily weather data for North America with comprehensive uncertainty quantification. *Nature Scientific Data*, DOI:: 10.1038/s41597-021-00973-0

https://daymet.ornl.gov

Daymet Version 4 lower-latency data product

- Daymet V4 lower-latency (LL)
  - Starting in Jan, 2021, Daymet daily data is provided on a monthly cycle
  - Published as a separate, provisional dataset
  - Thornton, M.M., R. Shrestha, P.E. Thornton, S. Kao, Y. Wei, and B.E. Wilson. 2021. Daymet Version 4 Monthly Latency: Daily Surface Weather Data. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1904

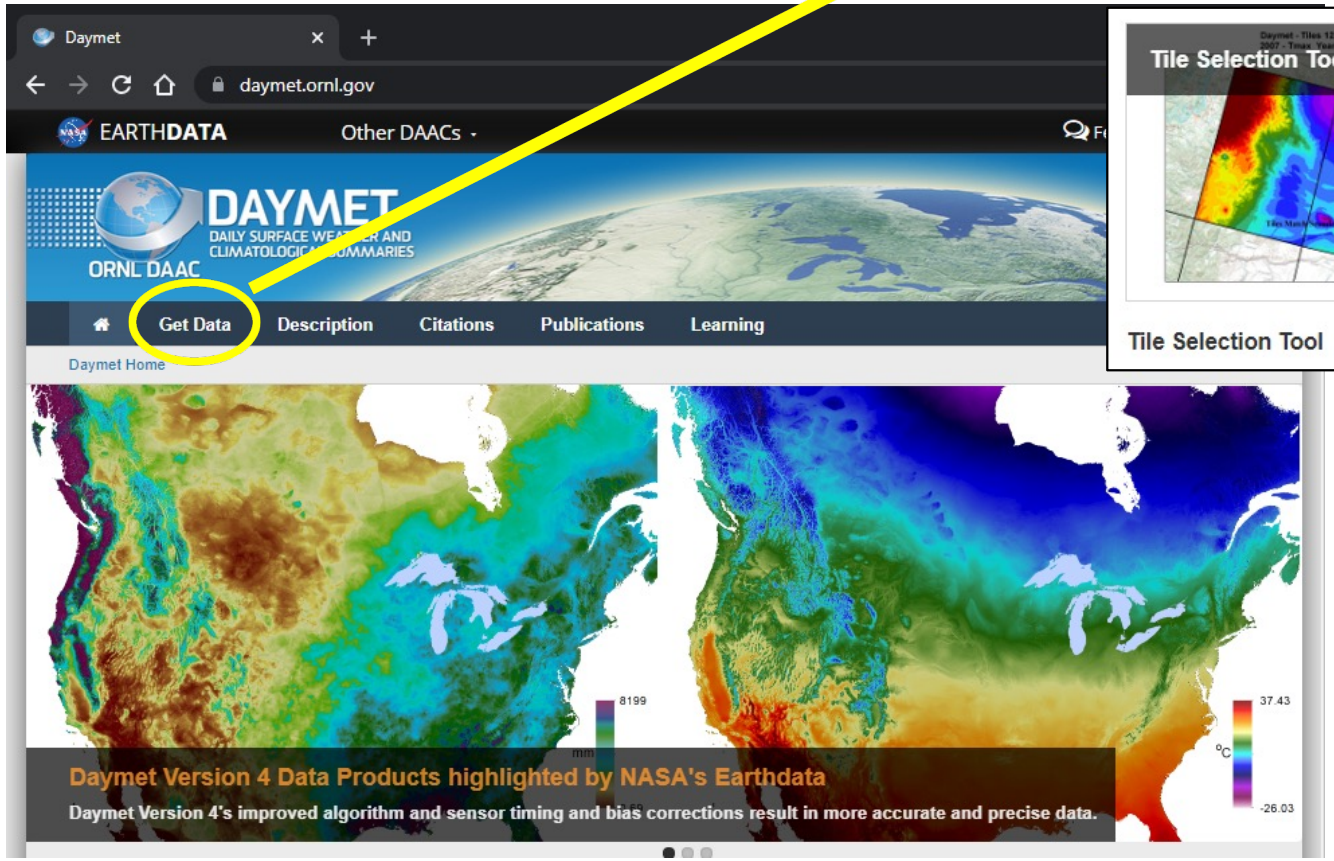


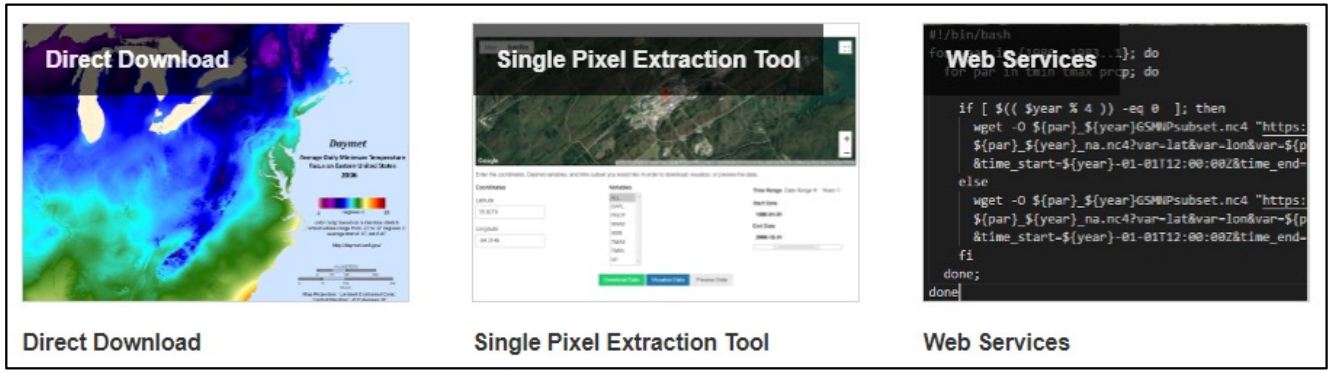
https://daymet.ornl.gov

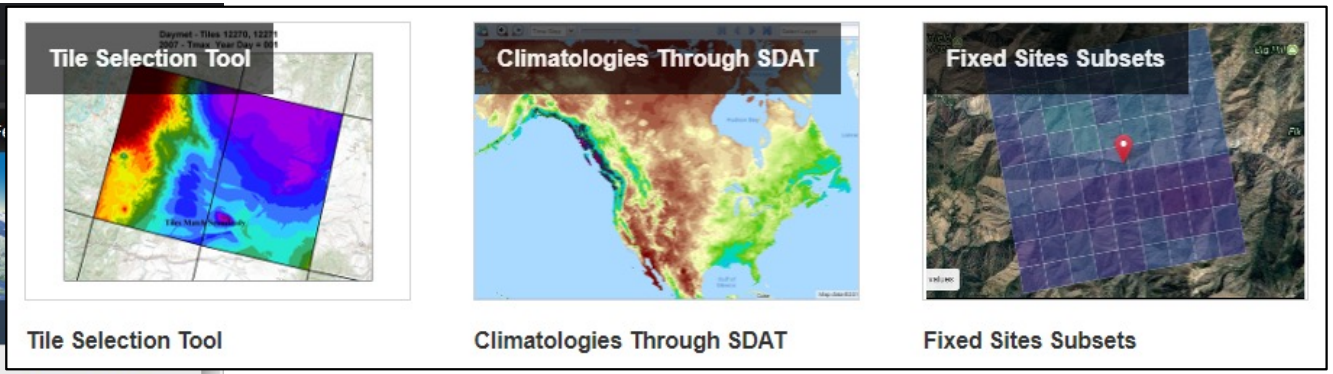
Daymet

- Daymet V4 Data Access

  https://daymet.ornl.gov



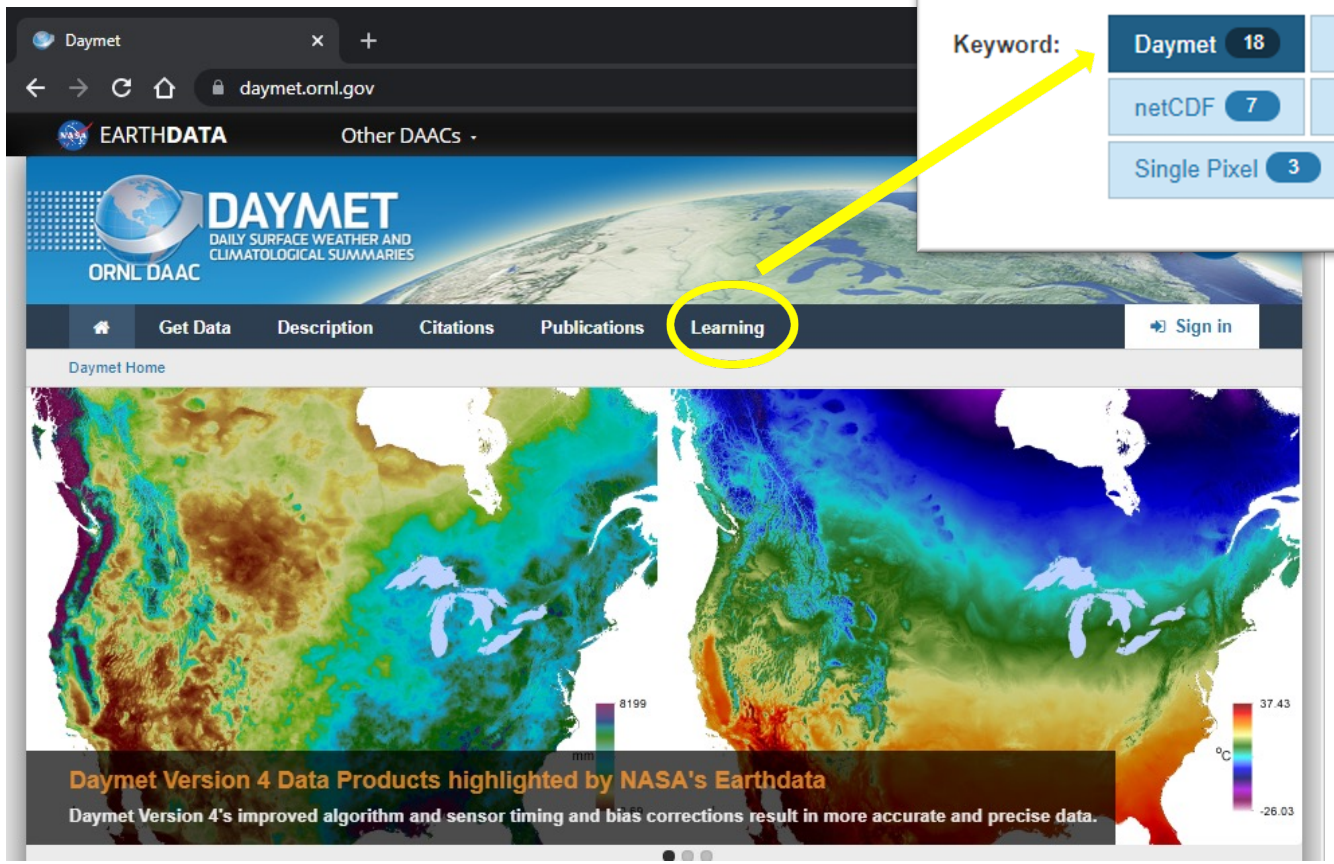


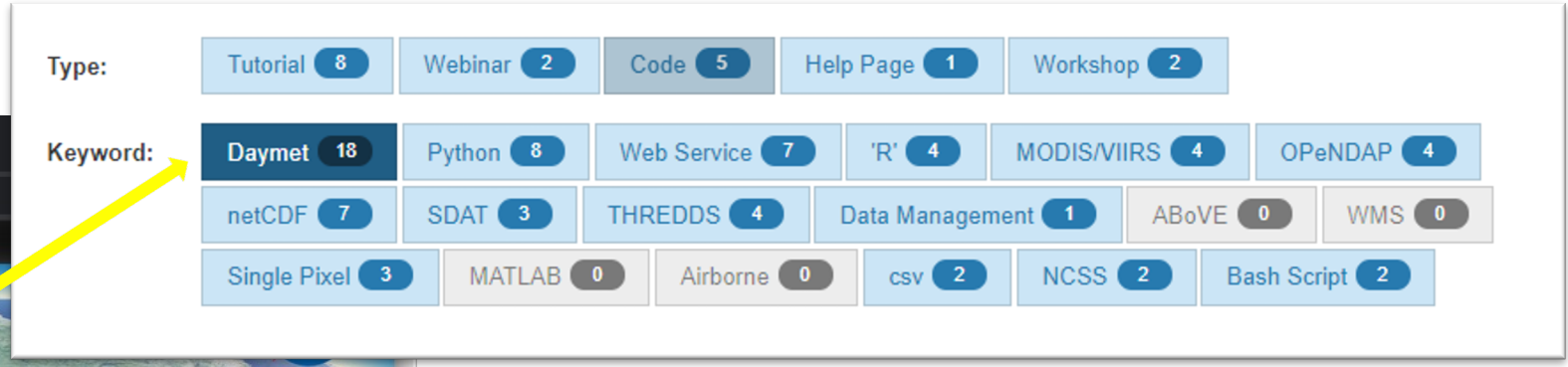


Daymet

- Daymet V4 Data Access

https://daymet.ornl.gov





Daymet/Lidar-SAR Applications in Ecology

- Publications showing synergistic use of Daymet & Lidar/SAR

Article | Published: 29 April 2021

Disturbance suppresses the aboveground carbon sink in North American boreal forests

Jonathan A. Wang, Alessandro Baccini, Mary Farina, James T. Randerson & Mark A. Friedl

Nature Climate Change **11**, 435–441 (2021) | Cite this article

PAPER • OPEN ACCESS

High-resolution forest carbon modelling for climate mitigation planning over the RGGI region, USA

L Ma[7,1], G Hurtt[1], H Tang[1], R Lamb[1], E Campbell[2], R Dubayah[1], M Guy[1], W Huang[1,3], A Lister[4], J Lu[1] + Show full author list

Published 6 April 2021 • © 2021 The Author(s). Published by IOP Publishing Ltd

Environmental Research Letters, Volume 16, Number 4

21 April 2020

Surface soil moisture estimation at high spatial resolution by fusing synthetic aperture radar and optical remote sensing data

Translator Disclaimer

Nengcheng Chen, Bowen Cheng, Xiang Zhang, Chenjie Xing

Author Affiliations +

J. of Applied Remote Sensing, 14(2), 024508 (2020). https://doi.org/10.1117/1.JRS.14.024508

Topographic LiDAR/SAR Datasets at ORNL DAAC

- Airborne & derived Products
- TLS & related
- Space-borne & related
- SAR Datasets

Raw LiDAR (Processing Levels ~1-2)

Platform	Footprint	Technology	Description	Region	Time Period
Airborne	Large	Full-waveform	BOREAS Scanning Lidar Imager of Canopies by Echo Recovery (SLICER)	Canada	1996
Terrestrial	Small	Discrete return	ECHIDNA LIDAR Campaigns: Forest Canopy Imagery and Field Data	USA	2007-2009
Airborne	Small	Discrete-return	LiDAR Data for Forested Areas in Paragominas, Para	Brazil	2012-2014
Airborne	Small	Discrete-return	LiDAR and DTM Data from Tapajos National Forest in Para	Brazil	2008
Airborne	Small	Discrete-return	LiDAR and DTM Data from Forested Land Near Manaus, Amazonas	Brazil	2008
Airborne	Small	Discrete-return	LiDAR Data for Forested Sites on Borneo Island, Kalimantan	Indonesia	2014
Airborne	Small	Discrete-return	LiDAR Data for Mangrove Forests in the Zambezi River Delta	Mozambique	2014
Airborne	Small	Discrete-return	LiDAR Data, DEM, and Maximum Vegetation Height Product from Southern Idaho	USA	2014
TLS	Small	Discrete return	Terrestrial Lidar Scanning Forest-Tundra Ecotone, Brooks Range, Alaska	USA	2008-2018

Derived Products (Processing Levels ~3-4) – Regional & Local

- 30+ data products
- Science variables
  - Aboveground biomass (AGB)
  - Canopy height metrics (CHM)
  - Tree cover (TC)
  - Topographic metrics (TM)
  - Vegetation map (VM)

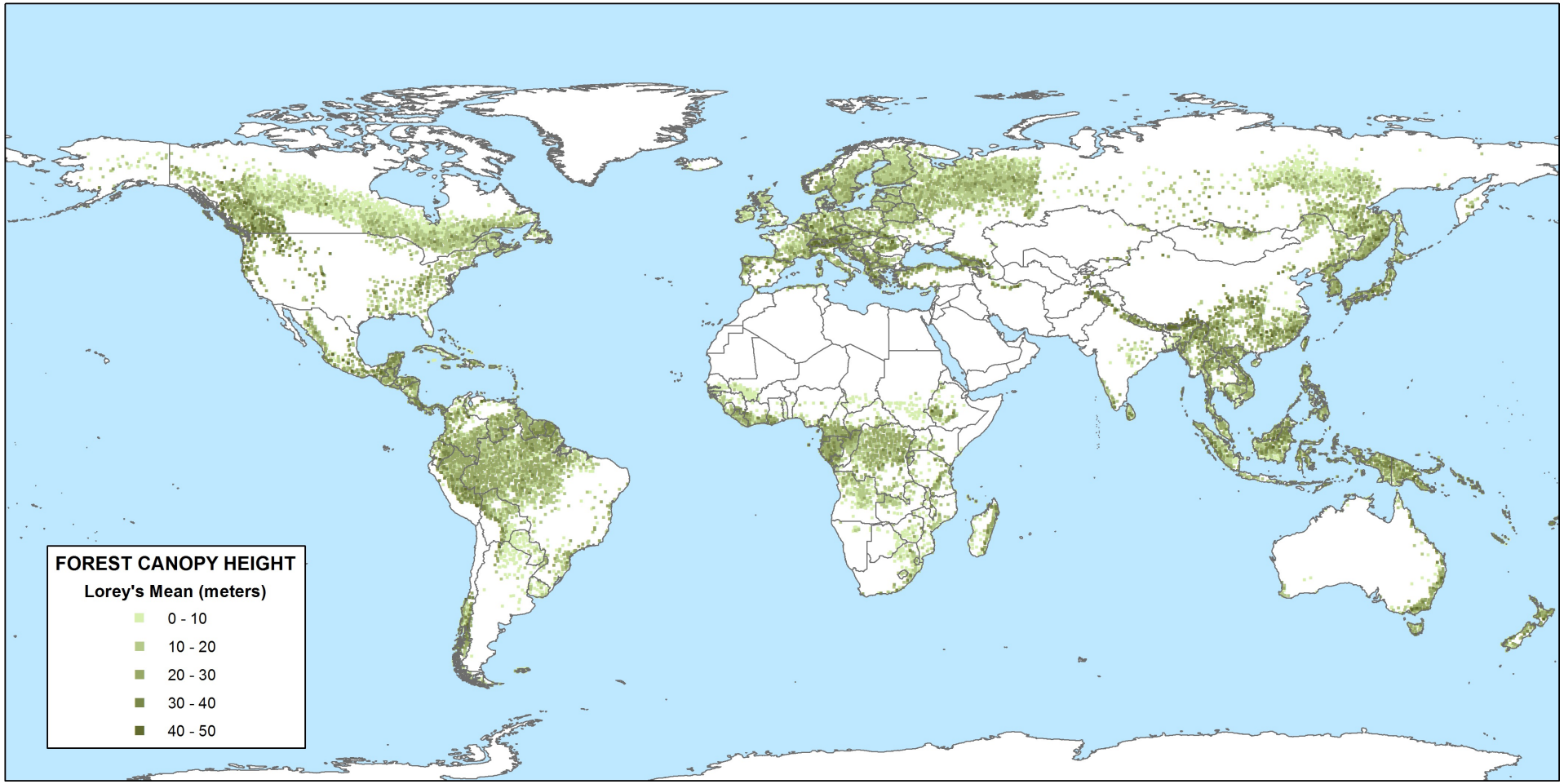
Science Variables*	Resolution	Description	Region	Time Period
AGB	20-50m	LiDAR-derived Estimates of Aboveground Biomass at Four Forested Sites	USA	2011
AGB	500m	LiDAR-based Biomass Estimates, Boreal Forest Biome	Alaska & Canada	2005-2006
AGB	500m	LiDAR-based Biomass Estimates, Boreal Forest Biome	N Eurasia	2005-2006
CHM	30m	LiDAR-derived Vegetation Canopy Structure, Great Smoky Mountains National Park	USA	2005-2006
CHM, TM	30m	Remote Sensing Data Before and After California Rim and King Forest Fires	USA	2010-2015
TM	1m	LiDAR Data for Forested Areas in Paragominas, Para	Brazil	2012-2014
CHM	100m	Canopy Height and Biomass from LiDAR Surveys at La Selva	Costa Rica	1998, 2005
AGB	13m	Aboveground Biomass from Penobscot Experimental Forest, Maine	USA	2012
TC	1m	LiDAR-derived Tree Canopy Cover for States in the Northeast USA	USA	2008, 2013, 2014
CHM	1m	Mangrove Canopy Height Estimates from Remote Imagery, Zambezi Delta	Mozambique	2014
TM	1m	LiDAR and DTM Data from Tapajos National Forest in Para	Brazil	2008
TM	1m	LiDAR and DTM Data from Forested Land Near Manaus, Amazonas	Brazil	2008
AGB, CHM	1m	Aboveground Biomass for Mangrove Forest, Zambezi River Delta	Mozambique	2014
AGB, CHM, TC	30m	LiDAR-derived Biomass, Canopy Height and Cover, Sonoma County, California	USA	2013
CHM, TM	1m	LiDAR Data, DEM, and Maximum Vegetation Height Product from Southern Idaho	USA	2013
AGB, CHM	tree, 30m, 25m	LiDAR-Derived Aboveground Biomass and Uncertainty for California Forests	USA	2005-2014
AGB, CHM	30m	LiDAR Derived Biomass, Canopy Height and Cover for Tri-State (MD, PA, DE) Region	USA	2004-2014
CHM, TM	1m	LiDAR-derived Canopy Height, Elevation for Sites in Kalimantan	Indonesia	2014
AGB	0.8m	High-Resolution Shrub Biomass and Uncertainty Maps, Toolik Lake Area, Alaska	USA	2013
CHM#	Profile	Polarimetric Height Profiles by TomoSAR, Lope and Rabi Forests	Gabon	2016
CHM#	30m	Rainforest Canopy Height Derived from PolInSAR and Lidar Data	Gabon	2016
TM	1m	Permafrost Measurements and Distribution Across the Y-K Delta, Alaska	USA	2016
AGB, CHM, TC	100m	Aboveground Biomass, Landcover, and Degradation, Kalimantan Forests	Indonesia	2014
AGB#	50m	LiDAR and PALSAR-Derived Forest Aboveground Biomass, Paragominas, Para	Brazil	2012
AGB	50m	Forest Aboveground Biomass and Carbon Sequestration Potential for Maryland	USA	2011
AGB	30m	Disturbance History and Forest Biomass from Landsat for Six US Sites	USA	1985-2014
AGB	50m	Aboveground Biomass for Lope, Mabounie, Mondah, and Rabi Sites	Gabon	2010-2016
VM	20cm	High-Resolution Vegetation Community Maps, Toolik Lake Area, Alaska	USA	2013-2015
AGB	30m	Annual Aboveground Biomass Maps for Forests in the Northwestern USA	USA	2000-2016
AGB	30m	LiDAR Biomass Improved for High Biomass Forests, Sonoma County, CA	USA	2013
AGB, CHM, TC, TM	25m	Gridded Forest Biomass and Canopy Metrics Derived from LVIS	Gabon	2016
AGB, TC	100m	Gridded Estimates of Woody Cover and Biomass across Sub-Saharan Africa	Africa	2000-2004
TM	1m	Digital Elevation Models for the Global Change Research Wetland, Maryland	USA	2011
AGB	30m	Annual Aboveground Biomass for Boreal Forests of ABoVE Core Domain	USA	1984-2014
AGB	500m	Aboveground Biomass Change for Amazon Basin, Mexico, and Pantropical Belt	Pantropical	2003-2016
AGB	30m	LiDAR Derived Biomass, Canopy Height, and Cover for New England Region	USA	2015

Derived Products (Processing Levels ~3-4) - Global

Science Variables*	Resolution	Description	Time Period
CHM	Site	GLAS LiDAR-derived Global Estimates of Forest Canopy Height	2004-2008
AGB, CHM	30m	Global Mangrove Distribution, Aboveground Biomass, and Canopy Height	2000-2009
CHM, TM	1000m	GEDI L3 Gridded Land Surface Metrics	2019-2020
CHM$	1000m	Global 1km Forest Canopy Height	2011

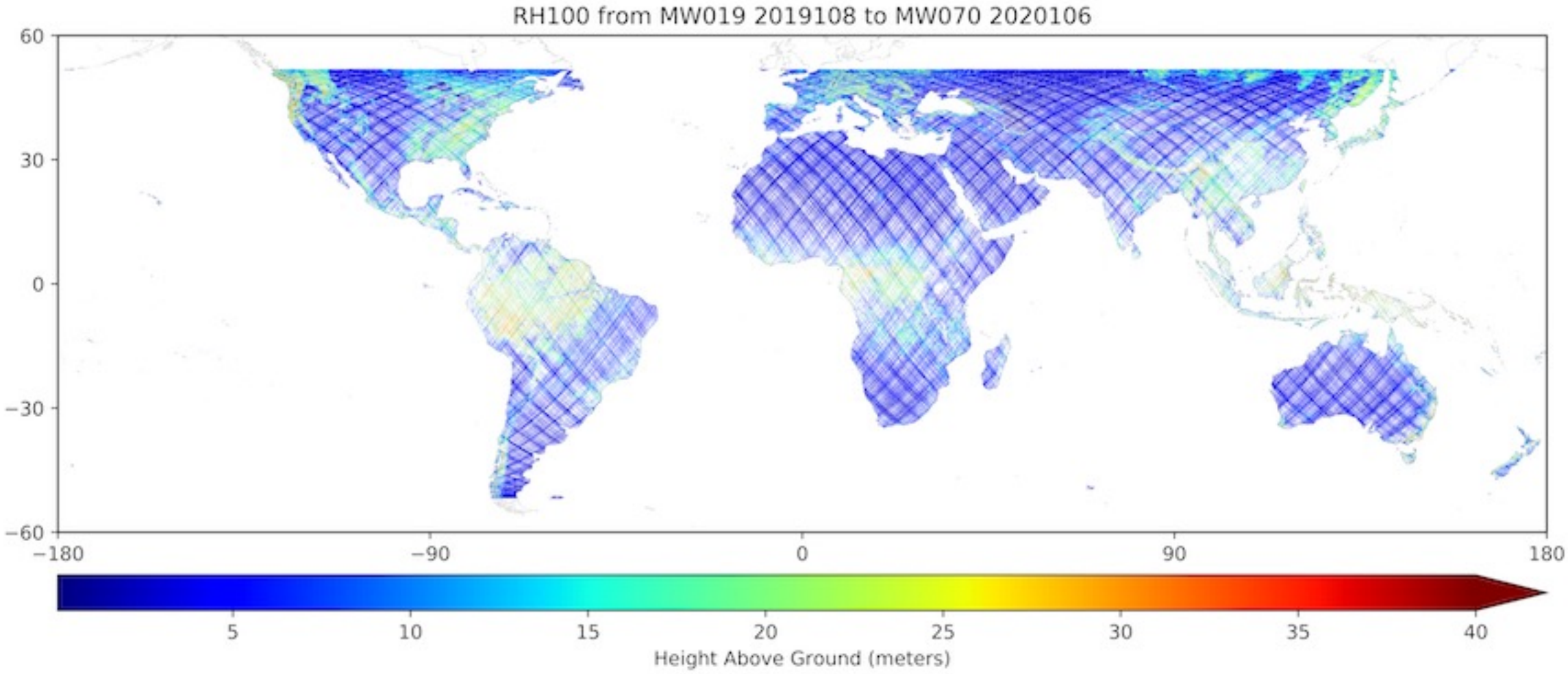
AGB = aboveground biomass; CHM = canopy height metrics; TC = tree cover; TM = topographic metrics

GLAS LiDAR-derived Global Estimates of Forest Canopy Height, 2004-2008



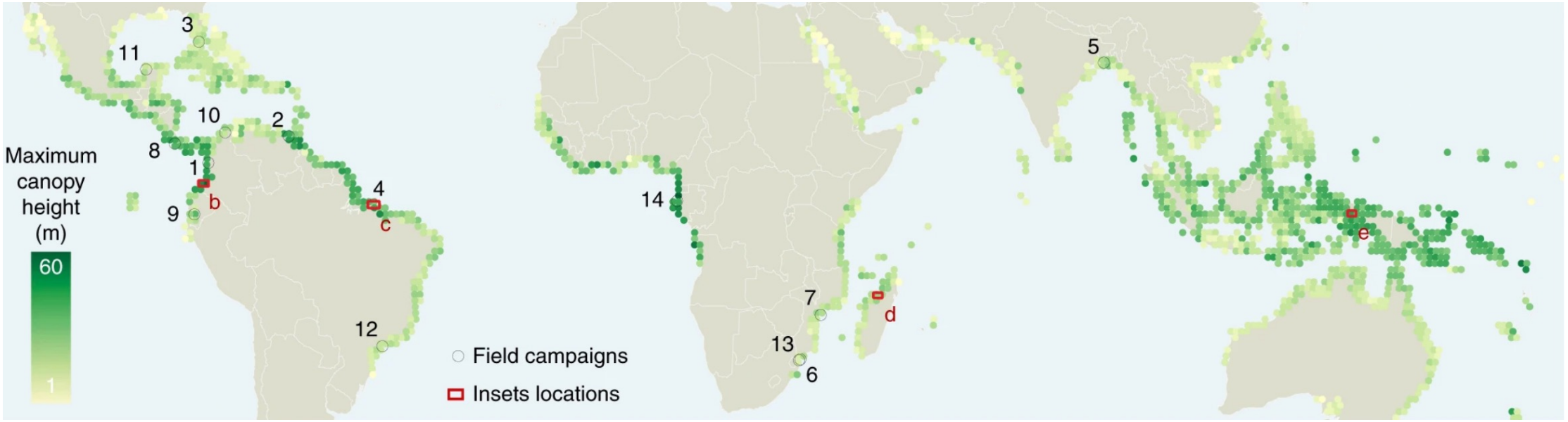
Dataset: Healey et al., 2015. https://doi.org/10.3334/ORNLDAAC/1271

GEDI L3 Gridded Land Surface Metrics



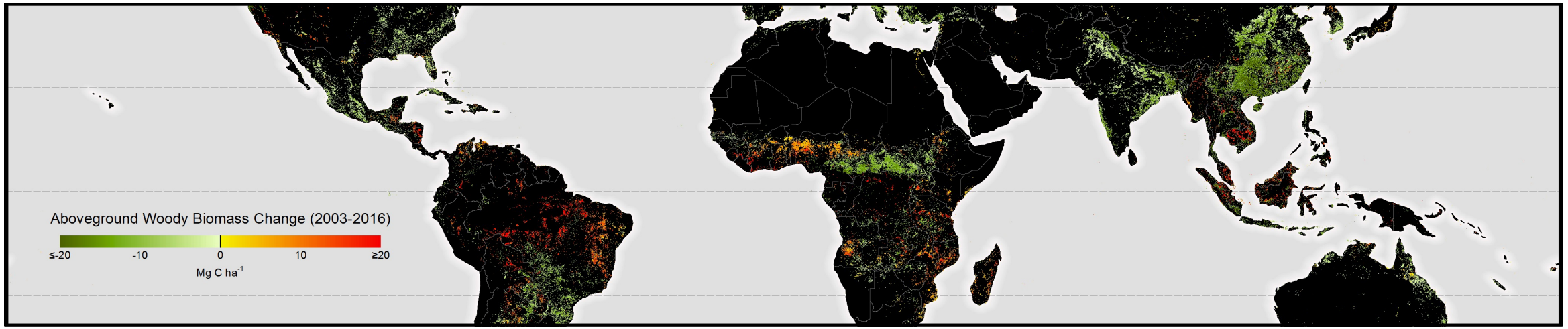
Dataset: Dubayah et al., 2021. https://doi.org/10.3334/ORNLDAAC/1865
Method: Luthcke et al., 2021.
https://daac.ornl.gov/daacdata/gedi/GEDI_L3_Land_Surface_Metrics/comp/GEDI_ATBD_L3R01.pdf

Global Mangrove Distribution, Aboveground Biomass, and Canopy Height



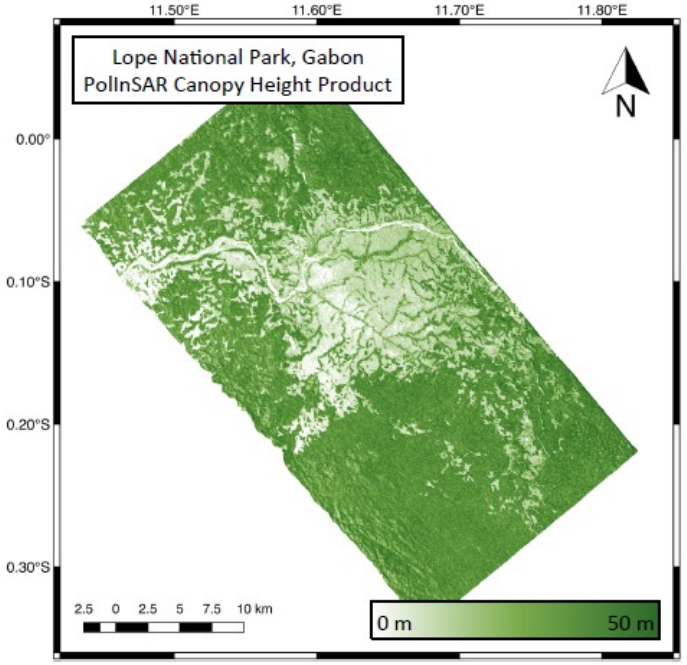
Dataset: Simrad et al., 2019. https://doi.org/10.3334/ORNLDAAC/1665

Aboveground Biomass Change for Amazon Basin, Mexico, and Pantropical Belt, 2003-2016



Dataset: Baccini et al., 2019. https://doi.org/10.3334/ORNLDAAC/1824

Synergistic Applications: SAR and LiDAR



Fusion of polarimetric synthetic aperture radar interferometry (PolInSAR) and land, vegetation, and ice sensor (LVIS) lidar data for canopy height estimation

Dataset: Denbina et al., 2018. https://doi.org/10.3334/ORNLDAAC/1589
Method: Denbina et al., 2018. https://doi.org/10.1109/JSTARS.2018.2841388